Intel® UEFI Development Kit 2010 and Intel® Boot Loader Development Kit: Foundations for Advanced Embedded Development

Alex Gu, Engineering Manager, Intel
Jason Jin, Technical Marketing Engineer, Intel

EFIS004
Agenda

- Intel® UEFI Development Kit 2010 Key Features
- Embedded Device Boot Loader
- Intel® Boot Loader Development Kit Key Features
- Summary
Agenda

- Intel® UEFI Development Kit 2010 Key Features
- Embedded Device Challenges
- Intel® Boot Loader Development Kit Key Features
- Summary
Intel® UDK2010 Enables a Common Firmware Development Foundation Across the Compute Continuum

- Netbooks
- Smartphones
- TVs
- Gadgets
- Desktop PCs
- Networks
- Data Center / Servers
- Embedded: Auto, Signage, Printers, etc.

Intel® UDK2010
Spotlight on Select Intel® UDK2010 Features

- UEFI Specification Support
- Packaging
- Multiple compilers and OS development environment support
- Platform Configuration Database
- Well defined and Optimized Libraries
- Source Level Debugger
- Security
- IP6 Networking
UEFI Specification Support

• Intel® UDK2010 Native support:
  – UDK2010 includes support for UEFI 2.2, UEFI 2.3, PI 1.1, and PI 1.2 (as well as all previous UEFI, EFI, and PI Specifications)
    ▪ Shell 2.0 specification support in separate shell package
  – Pre-UDK contained definitions for UEFI 2.0, UEFI 2.1, PI 1.0 and Framework 0.9x Specifications; focused on UEFI 2.1 and PI 1.0 (PEI Core, DXE Core, PEIMs, DXE Drivers, UEFI Drivers, and libraries)

Security/Networking - UEFI 2.3
• IPV6/IPSec – next gen internet IP address allocation and security
• User Authentication & Driver Signing
• iSCSI & VLAN

Human Infrastructure Interface (HII) – UEFI 2.1
Packaging: Enabling Fast Delivery of Advanced Capabilities to Market

Example of Package-based deployment

- **Package 1** Industry standard modules and drivers
- **Package 2** Chipset PEIM’s and DXE drivers
- **Package 3** System board code
- **Package 4** OEM Value-add

*Intel® UDK2010 enables all the pieces to fit together and work!*
Multiple Compilers and OS Development Environment Support Improvement over EDK

<table>
<thead>
<tr>
<th></th>
<th>EDK</th>
<th>UDK 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development OS</td>
<td>Windows* XP</td>
<td>Windows XP, Windows 64, Vista32, Vista64, Linux*, OS/X*</td>
</tr>
<tr>
<td>Build</td>
<td>nmake</td>
<td>nmake, gmake</td>
</tr>
<tr>
<td>Build Tools</td>
<td>C</td>
<td>POSIX C, Python*</td>
</tr>
</tbody>
</table>

Improved Features and Support

GCC GNU Compiler Collection for C++
POSIX C Portable Operating System Interface for Unix
Platform Configuration Database

- Improve developer efficiency
- Maximize modules reuse across platforms and minimize source code editing
- Speed up development
Optimized Libraries

- Allow common function to be extended safely/efficiently
- Size/Performance optimized
- Allows platform teams to define custom implementations for standard interfaces
- Based on Industry specs (UEFI, PI, SmBios, ACPI, Etc...)
- Increase development speed and quality.
Source Level Debugger

The Intel® UDK2010 contains a Source Debugger Package:

- Interface and use like the standard Windows* WinDBG* tool
  - Low learning Curve
  - Robust operation
  - Support from early pre-boot phase
- Integrated directly into the Pre-boot image of the platform
- Uses Serial or USB port for communications to host platform
Intel® UDK2010 Available on tianocore.org

http://www.tianocore.Sourceforge.net

Intel® UDK2010
Open Source
UEFI Development Kit

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- Intel® UEFI Development Kit 2010 Key Features
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Embedded Growth Today and Future

Embedded market is growing rapidly in diversity

PC / Server Like

Deeply Embedded
Lower Power
Lower Cost
Higher Integration
# Traditional BIOS vs. Embedded Boot Loader

<table>
<thead>
<tr>
<th>BIOS</th>
<th>Boot Loader</th>
</tr>
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<tbody>
<tr>
<td>Dynamically configures per Broad PC industry standards</td>
<td>Statically configures for a specific application</td>
</tr>
</tbody>
</table>

- Standard OS compatibility
- Feature richness
- Open to many use cases
- Multiple boot paths
- Extra services and support
- For a price

- Custom OS & applications
- Basic IA initialization
- Quick and small
- Single use case
- Limited boot options
- No frills
- Royalty free
- No hand-holding

**Intel® BLDK is designed for Embedded Boot Loader**
Embedded Device Boot loader Challenges

- Configurability (Device in Diversity)
- Performance (Speed is everything)
- Closed Source (Limits accessibility)
- Debuggability (Reduces TTM)

Intel® UDK2010 can address these challenges
Agenda

• UEFI Specification Evolution
• Intel® UEFI Development Kit 2010 Key Features
• Embedded Device Boot Loader
• Intel® Boot Loader Development Kit Key Features
• Summary
Intel® Boot Loader Development Kit

Documentation & Sample Reference Code
- Comprehensive instructional documents enable Self-Sufficiency and effective, scalable support

CRB Example Image & Firmware Code
- Example Intel CRB Image & BOM provides baseline from which customers can modify their system firmware image

Software Tools and GUI Interface
- GUI Module Selection & Build Tool allows custom image creation without direct code changes
- IDE facilitates Easy Navigation and Modification of the Code

Intel BLDK is on http://goto.intel.com/bldk

Intel BLDK provides the mechanism for customers to develop their own boot loader solutions
Intel® BLDK Key Features

**Industry Standard Compliant**
- UEFI 2.0, UEFI 2.1, UEFI 2.2, UEFI 2.3 and PI 1.0, PI 1.1, PI 1.2
- ACPI 3.0

**Customer Binary Configuration**
- Feature selection and binary patchable without direct code change

**Multiple Tools Chains Support**

**Multiple Boot Device**
- Boot from ATA, SSD, CF, SD, USB, FWH, SPI, iSCSI, PXE

**Source Level Debug**
- UDK Debugger Tool provide pure soft debug solution

**Extensible Foundation**
- Pre-OS Security, Rich Networking, Manageability, etc.

**Royalty-free Source Code**
- Majority of source available via tiano.org

*Intel® UDK2010 is the best choice of firmware code*
Intel® Atom™ Processor E6xx Series with Intel® Platform Controller Hub EG20T Platform (Codename Crown Bay) – Based on Intel® UDK2010
Address Challenge – Configurability

- Configurability is a key feature in embedded
  - Ability to customize behavior and optimize for the target environment involves what might be some changes to the normal desktop PC behavior model.
  - Is there a UI to launch?
  - What type of hardware are we required to initialize prior to launching the payload?

The embedded space has some unique policy decisions
Address Challenge - Performance

- Boot Target Hardware Choice
  - Boot device spin-up/down time affects performance
  - Use of an SSD boot device in lieu of rotating media can save seconds in the boot time

<table>
<thead>
<tr>
<th>Values</th>
<th>DRAM</th>
<th>SSD (34nm)</th>
<th>EIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read Latency</td>
<td>~30 ns</td>
<td>65 (\mu)s</td>
<td>8.5 ms</td>
</tr>
<tr>
<td>Read BW (MB/s)</td>
<td>1800</td>
<td>250</td>
<td>120</td>
</tr>
<tr>
<td>Write Latency</td>
<td>~30 ns</td>
<td>85 (\mu)s</td>
<td>10 ms</td>
</tr>
<tr>
<td>Write BW (MB/s)</td>
<td>1800</td>
<td>70</td>
<td>120</td>
</tr>
<tr>
<td>Spin-up/down time</td>
<td>N/A</td>
<td>N/A</td>
<td>1-2s++</td>
</tr>
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</table>
Address Challenge – Performance (Cont)

- FLASH Organization
  - Flash layout affects performance
  - Organize FLASH layout so that you only search firmware volumes which contain items of interest for that configuration

The more organized layout, the faster boot time
Address Challenge – Performance (Cont)

- Note that depending on platform needs, we may very well do different things...

The more customized boot sequence, the faster boot time
Address Challenge – Performance (Cont)

- Performance Optimization doesn’t mean we lose UEFI compatibility

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**Non-Optimized Boot**

- SEC Phase: Pre-memory early initialization, microcode patching, and MTRR programming.

  - PEI Phase: Dispatches various PEI drivers. Pre-memory early initialization, microcode patching, and MTRR programming.

  - Are we in an S3 Boot mode?
    - Yes: O/S Resume Vector
    - No: DXE + BDS Phase
      - Discover all drivers available to the platform. Dispatch all drivers encountered.

**Optimized Boot**

- SEC Phase: Pre-memory early initialization, microcode patching, and MTRR programming.

  - PEI Phase: Dispatches only minimal PEI drivers. Pre-memory early initialization, microcode patching, and MTRR programming.

  - Are we in an S3 Boot mode?
    - Yes: O/S Resume Vector
    - No: DXE + BDS Phase
      - Discover the drivers available to the platform. Dispatch only the minimal drivers required to boot the target

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Address Challenge – Closed Source

- Limited access to certain source material
  - Traditionally, closed source code and distribution restrictions in a Boot Loader has made distribution to a wide audience a challenge.

**UEFI introduces a large amount of open source**

[www.tianocore.org](http://www.tianocore.org) forwards user to a Source Forge repository.

Relatively small portion remains
With source & distribution restrictions
Address Challenge—Closed Source (Cont)

- By extending the configurability of binary components, we can enable much broader usage.

Binary image manipulation removes source restriction hurdles so a large variety of clients can use solution.
Address Challenge – Debbuggability

• Software-only debugger solution
  – New Intel® UEFI Development Kit Debugger Tool available
  – Provides ability to debug target without need for exposed JTAG
    ▪ Leverage various debug ports (e.g. USB, Serial)
  – Supports WinDbg* as a front-end
  – Few differences between this solution and a high-end HW-based debugger
    ▪ To break into target, SEC startup code must have established a stack.
      – Typically a few dozen instructions from the reset vector.
      – This is also true of first few dozen instructions in SMI entry.
    ▪ Some Processor mode transitions are difficult to debug.

UEFI-based open source debugger solutions available
Address Challenge – Debuggability (Cont)

- Intel® UEFI Development Debugger Tool Architecture

![Diagram showing the architecture of Intel® UEFI Development Debugger Tool]

- Host Machine
  - WinDbg*
  - WinDBG Interposer
  - PDB and Source
  - Debug Channel

- Target Machine
  - Debug Agent
  - Debug Interrupt Handler
  - Debug Channel
  - Normal Code Flow

- UART

PDB file generated by Visual Studio on Windows

Edit COM interface by Microsoft

COM interface
Address Challenge – Debuggability (Cont)

- WinDBG* should stop the TARGET at late SEC phase, and loaded the symbols for SecCore. WinDbg will show the source code similar to the example shown.

- Bottom window allows commands to be entered:
  - .reboot
  - Smmentrybreak=1 or 0
  - g - Go
  - B[C|D|E][<bps>] - clear/disable/enable breakpoint(s)
  - Q - quit
  - ? – Command list

```c
AsmWriteDr7 (0x20000480):
AsmWriteCr4 (Cr4 | BIT3):
    //
    // Do an IN from IO_PORT_BREAKPOINT_ADDRESS to generate =
    // returns a read value other than DEBUG_AGENT_WAIT
    //
    do {
        DebugAgentStatus = IoRead3 (IO_PORT_BREAKPOINT_ADDRESS)
    } while (DebugAgentStatus == DEBUG_AGENT_IMAGE_WAIT);
    }
    else if (LoadImageMethod == DEBUG_LOAD_IMAGE_METHOD_SOFT_
    // Generate a software break point
    //
    CpuBreakpoint ();
    }
    //
    // Restore Debug Register State only when Host didn't change.
    // E.g.: User halts the target and sets the HW breakpoint in
    // above exception handler.

NewDr7 = AsmReadDr7 ();
if (!IsDrxEnabled (0, NewDr7)) {
    AsmWriteDr0 (Dr0);
} else if (IsDrxEnabled (1, NewDr7)) {
    AsmWriteDr1 (Dr1);
Summary

- Intel® UEFI Development Kit 2010 (Intel® UDK2010) meets newest Industry Standard and provide a well suited development base.
- Intel® Boot Loader Development Kit (Intel® BLDK) offers a solution to develop Intel® Atom™ Processor based embedded design rapidly.
- Intel UDK2010 is the best choice of firmware to help Intel BLDK to address embedded design challenges.
Additional resources on UEFI:

- Other UEFI Sessions – Next slide
- More web based info:
  - EDK II Open Source Implementation: www.tianocore.org

# EFI Track Sessions

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<th>Title</th>
<th>Day/Time</th>
<th>Room</th>
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<td>EFIS001</td>
<td>Microsoft* Windows* Platform Evolution and UEFI</td>
<td>Tuesday 11:10</td>
<td>306A</td>
</tr>
<tr>
<td>EFIS002</td>
<td>UEFI Development and Innovations for System-On-Chip (SoC)</td>
<td>Tuesday 14:05</td>
<td>306A</td>
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<tr>
<td>EFIS003</td>
<td>UEFI and Transparent Computing Technology</td>
<td>Tuesday 15:10</td>
<td>306A</td>
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<tr>
<td>EFIS004</td>
<td>Intel® UEFI Development Kit 2010 and Intel® Boot Loader Development Kit: Foundations for Advanced Embedded Development</td>
<td>Tuesday 16:10</td>
<td>306A</td>
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<tr>
<td>SPCQ001</td>
<td>Hot Topic Q&amp;A: Intel® Boot Loader Development Kit (Intel® BLDK)</td>
<td>Tuesday 17:00</td>
<td>306A</td>
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<td>EFIS005</td>
<td>Security and Networking Advancements Today’s UEFI and Intel® UEFI Development Kit 2010 (Intel® UDK2010)</td>
<td>Wednesday 11:10</td>
<td>306A</td>
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